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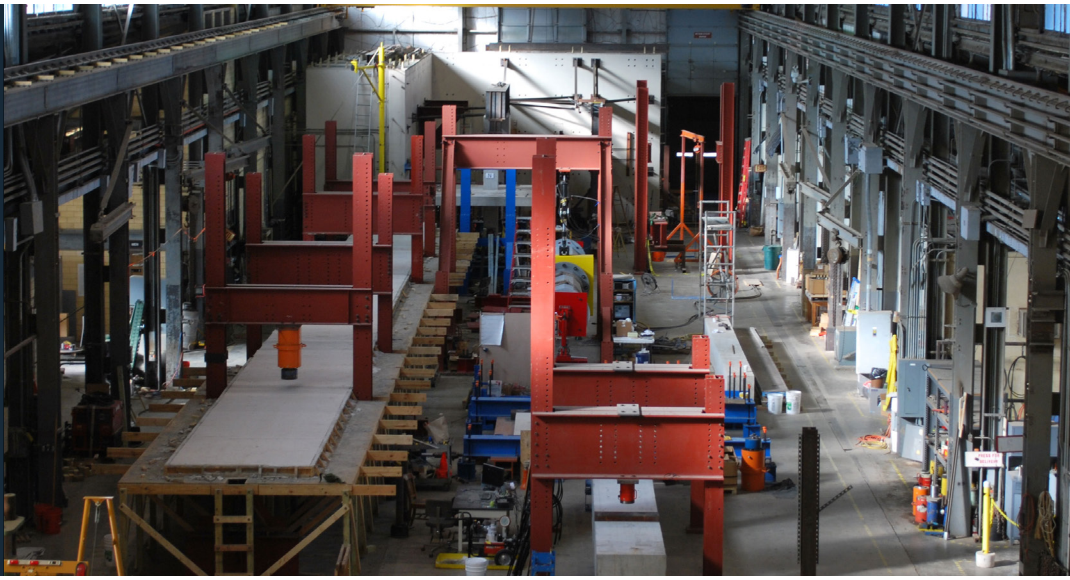


FSEL NEWSLETTER

Volume No 13, Issue No 1, May 2022

FSEL

The Ferguson Structural Engineering Laboratory (FSEL) located on the Pickle Research Campus of The University of Texas at Austin is named after Professor Phil M. Ferguson, who was an inspirational teacher and a meticulous researcher.

We hope that you enjoy learning about our laboratory and ongoing research.

ONGOING RESEARCH AT FSEL

There are 39 student researchers working at FSEL, and this newsletter summarizes some our ongoing projects. We hope you enjoy learning more about the exciting work we do at FSEL!

SYSTEM LEVEL SEISMIC PERFORMANCE OF STEEL GRAVITY FRAMING PROJECT

PROJECT TEAM: SANGWOOK PARK

EXTERNAL ADVISORS: LAWRENCE KRUTH, PATRICK MCMANUS, THOMAS SPUTO, & JUDY LIU

SUPERVISORS: ERIC WILLIAMSON, TODD HELWIG, MICHAEL ENGELHARDT, & PATRICIA CLAYTON

This research investigates the seismic performance of steel gravity framing with composite floor slabs, considering system-level behavior. To better understand the system-level behaviors, large-scale tests on a multi-bay structure will be conducted to estimate the contribution of the gravity framing on a building's seismic resistance. A specimen has been designed for two-half stories and two-by-three bays of steel gravity framing with composite floor slabs. In addition, the orientation of the metal decking will be considered as one of the major design variables, so that a total of two specimens need to be examined in the project.

The first specimen has been fabricated last year, and the testing was recently conducted under the quasi-static, displacement-controlled cyclic loading protocol. Our project team is analyzing the testing data to investigate the flexural resistance of the composite connections when system-level effects and multi-bay interactions are considered. In the meantime, the demolition of the first specimen and the fabrication for the next specimen will be carried out.

Observed behavior of the first testing specimen

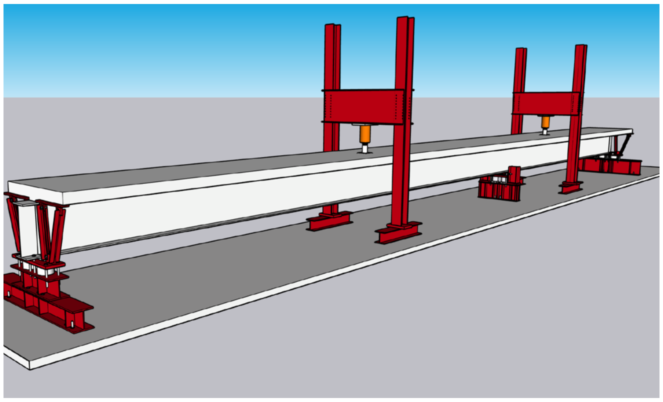
IN THIS ISSUE

USE OF LARGER DIAMETER SHEAR STUDS FOR COMPOSITE STEEL BRIDGES

PROJECT TEAM: LU WAN, XIANJUE DENG, & YUCEL ALP

SUPERVISORS: MICHAEL ENGELHARDT, TODD HELWIG, & ERIC WILLIAMSON

This project is to investigate the feasibility of using larger diameter shear studs in composite steel bridges. It mainly consists of three parts: welding investigation, push-out tests(static/fatigue) and large-scale beam tests. Welding investigation has been finished and welding procedures and quality control for larger diameter shear studs have been proposed. Until now static push-out tests have been done, and the research team is now working on conducting fatigue push-out tests and preparing for a series of large-scale beam tests. There are mainly two objectives of large-scale beam tests: the first one is to investigate the potential serviceability problems caused by larger diameter shear studs under service level load. This test will be done as shown in the illustration. The second one is to investigate whether larger diameter shear studs have enough ductility to develop fully composite strength of the composite girder. To do this test, the middle support will be removed to get a 100ft long simply supported beam and the beam will finally be loaded to failure.



Large-scale beam test under two span arrangement

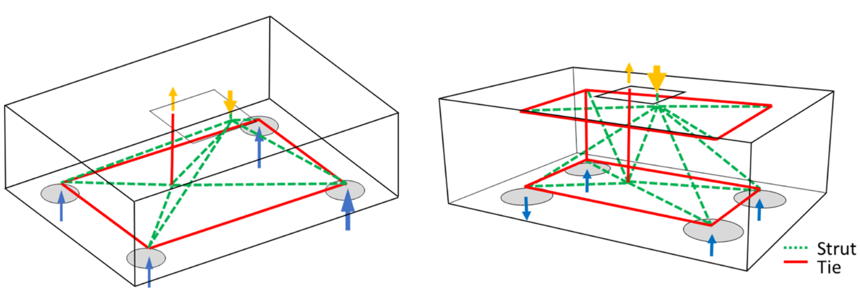
STRUT-AND-TIE MODELING AND DESIGN OF DRILLED SHAFT FOOTINGS: BIAXIAL LOAD COMBINATIONS

PROJECT TEAM: YOUSUN YI, DENNIS KIM, DENNIS WANG, & ZACH WEBB

SUPERVISOR: OGUZHAN BAYRAK

The reinforced concrete footings supported by a grid of drilled shafts generally have shear-to-span ratios smaller than two; therefore, the footings should be designed by the strut-and-tie model. The configuration of the model developed in the footings is three-dimensional (3D) to represent the internal force flow from the column to the drilled shafts. However, current specifications and design recommendations focus on two-dimensional (2D) strut-and-tie models. The research team had proposed design guidelines for drilled shaft footings subjected to various uniaxial loading scenarios using the 3D strut-and-tie method in the previous research project.

To supplement the guidelines, the research team continued the research work to cover biaxial flexure loading scenarios, which are frequently considered loading cases in designing drilled shaft footings. Study on a simple design flow chart and configuration of the 3D strut-and-tie model for the drilled shaft footings subjected to biaxial loading cases are underway. The design guidelines and design examples for the biaxial loading cases will be proposed by the end of this semester.



3D strut-and-tie models of drilled shaft footings under moderate biaxial flexural compression (left) and severe biaxial flexural compression (right)

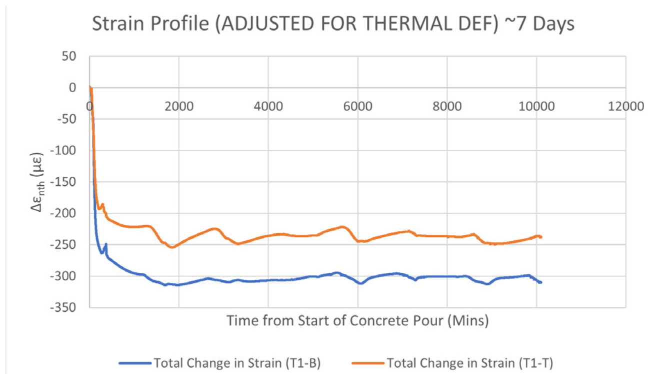
EVALUATE PERFORMANCE OF CLOSURE JOINTS FOR SIDE-BY-SIDE ACCELERATED BRIDGE CONSTRUCTION (ABC) SUPERSTRUCTURE SYSTEMS

PROJECT TEAM: NIYAM SHAH, DENNIS WANG, & ZACH WEBB

SUPERVISORS: OGUZHAN BAYRAK & KEVIN FOLLIARD

The main problem facing engineers and contractors today is devising a plan to fix deteriorating bridges while also accommodating vehicles on the roadway. To combat the outmoded methods of constructing/rehabilitating bridges, a method known as Accelerated Bridge Construction (ABC) was devised. ABC accomplishes the goal of minimizing traffic disruptions and construction time by utilizing prefabricated bridge elements. To provide continuity between these elements, a connection known as a closure joint must be used. Closure joints are critical in ABC and help transfer shear and moment between deck panels. Closure joints can use normal-strength concrete, ultra-high performance concrete (UHPC), or a combination mix in between, and are coupled with the use of different reinforcement details (e.g., straight bars, hooked bars, etc.). However, there has been concern regarding the long-term durability of closure joints due to their cast-in-place nature and material/reinforcement specifications.

The research team is currently analyzing strain and temperature data collected from two instrumented TxDOT ABC bridges in the Bryan and Amarillo Districts. This data will help evaluate the structural performance of the closure joints and validate the predictions of the bridges' design stresses. Also ongoing is the design of large-scale test specimens for four-point flexure and shear tests.



Local Closure Joint Strain Profile Adjusted for Thermal Deformation

DEVELOP AND VALIDATE PRECAST COLUMN SOLUTIONS FOR TEXAS BRIDGES

PROJECT TEAM: LUKE SMALL, LUCAS ZILVETI, JOHN PARK, ZACH WEBB, & DENNIS WANG

SUPERVISOR: OGUZHAN BAYRAK

Cracking in the shell of a composite element and core displacement due to a slip failure of the interface from the small-scale experimental program

Precast bridge elements can be used to accelerate bridge construction and reduce road closures and associated traffic. The goal of TxDOT Project 0-7089 is to investigate alternative precast column systems that can accomplish these goals while also being more economical than current cast-in-place designs.

So far, the project team has completed a literature review and preliminary design. A small-scale testing program investigating interface shear characteristics is also nearing completion. The results of this study will be used to further inform design of a hybrid precast column system consisting of a hollow precast shell that is later filled with cast-in-place concrete to form connections with a foundation and bent cap. This design will be tested during a large-scale experimental program along with other proposed alternatives including fully cast-in-place designs and solid precast columns. The construction phase of the large-scale testing program is anticipated to begin in late spring.

Concurrently, a finite element analysis will be conducted in order to verify both the small-scale testing program results, as well as inform and verify designs created throughout the large-scale testing program.

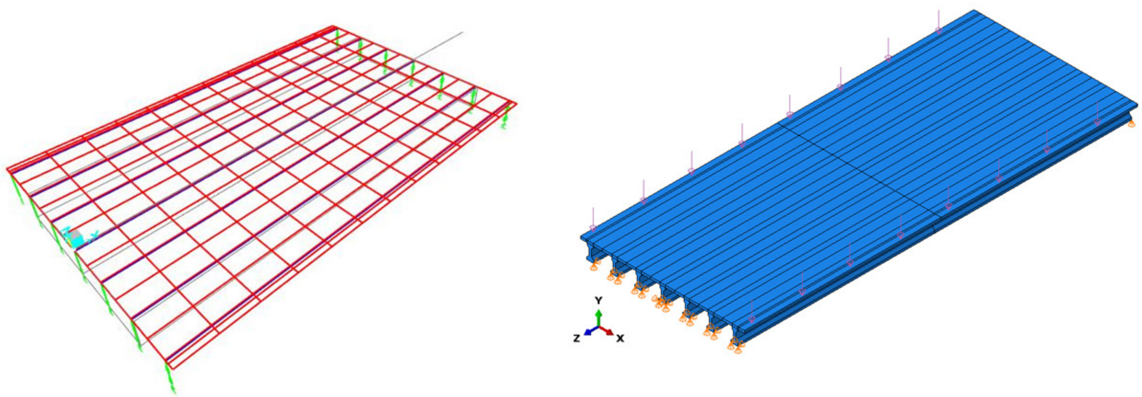
Test specimen after test completion

DEVELOP DECK AND OVERHANG DESIGN GUIDELINES FOR SOUND WALLS AND OTHER HEAVY LOADS

PROJECT TEAM: BHUSHAN RAJ SELVARAJ, TANAKORN NGAMJARUNGJIT

SUPERVISORS: ERIC WILLIAMSON, TODD HELWIG, & MICHAEL ENGELHARDT

Economic considerations typically encourage limiting the total number of girders across the width of most bridges. The portion of a bridge deck extending past the fascia girders is known as the overhang. The width of overhangs is normally proportioned so that the same girder sections can be used for both the interior and fascia girders. While many state transportation agencies have guidelines on sizing and detailing bridge overhangs, current provisions are generally based on rules-of-thumb developed through past experience. Current provisions, however, are not sufficient for designing bridge deck systems that include large edge loads. Thus, heavy railings such as TxDOT's T80TT, which is taller and heavier than typical railings, cannot be used in many bridge applications where they may desirable. The purpose of this project is to evaluate current design practices and procedures, using parametric finite element analyses, so that design guidelines can be developed to proportion bridge deck systems with heavy railings having a high crash rating. The research team has conducted a literature review to identify the best design practices, past research, and methods of analysis for deck overhangs with railings. Currently, they are focusing on developing preliminary design guidelines and identifying how the selection of bridge railing system influences the bridge deck design and girder spacing. In the next steps, appropriate software for modeling these systems will be identified and up to four different bridge systems will be chosen to represent the various parameters that play important role in the detailed design.



Analyses of Bridge Supporting Heavy Railings

INVESTIGATE LIVE LOAD DISTRIBUTION AND STABILITY OF PS CONCRETE GIRDERS DURING CONSTRUCTION

PROJECT TEAM: PAUL TACKETT

SUPERVISORS: TODD HELWIG, MICHAEL ENGELHARDT, ERIC WILLIAMSON, & MATT HEBDON

Continued strides in prestressed concrete girder design and construction methods have resulted in more slender and longer span structures. This has increased viable span lengths from ~150 ft. for conventional applications to near 300 ft. These long-span, prestressed structures often incorporate spliced construction and tapered sections. Historically, concrete beam structures have been controlled by strength and service requirements that result in stocky sections which have not been susceptible to stability related failures. This study seeks to evaluate the stability behavior of these newer, more slender prestressed girder applications during all phases of construction. The effects and requirements of bracing and live load distribution are of particular interest.

DEVELOPMENT OF KNOWLEDGE IN THE APPLICATION OF STRUT-AND-TIE MODELING

PROJECT TEAM: ANAS DAOU, DENNIS WANG, YIBIN SHAO, AYAH ALOMARI, & ZACH WEBB

SUPERVISOR: OGUZHAN BAYRAK

For the Curved-bar-node task, Group members are investigating the effect bend radius on the Strut-and -tie model (STM) and the shear strength of beam-column joints. The first two specimen construction is completed, and testing is expected to be in process. The mechanics of load transfer by using high-fidelity instrumentation is studied. Accompanying FEM models for the test specimens shall inform the study of the mechanics of load transfer.

For the confined nodal region study, the research team aims to study and analyze the beneficial effect of confinement on nodal regions in the STM through an experimental program and analytical methods. Currently, the project has accomplished the preliminary theoretical analysis, fabricated testing set up, and tested CCC node in the first specimen.

For the crack control study, the research aims to investigate the feasibility of relaxing the maximum spacing requirement of crack control reinforcement. This will be accomplished through a large-scale experimental program of three specimens (or six tests), finite element analysis. Currently, the project has completed the fabrication of its first specimen and will be tested later this March.

Rebar cage for first specimen being lifted into the formwork for cast

Curved-bar-node Steel First specimen

EVALUATION OF SEAMLESS BRIDGES

PROJECT TEAM: XIAOYI CHEN, BEHDAD MOFARRAJ

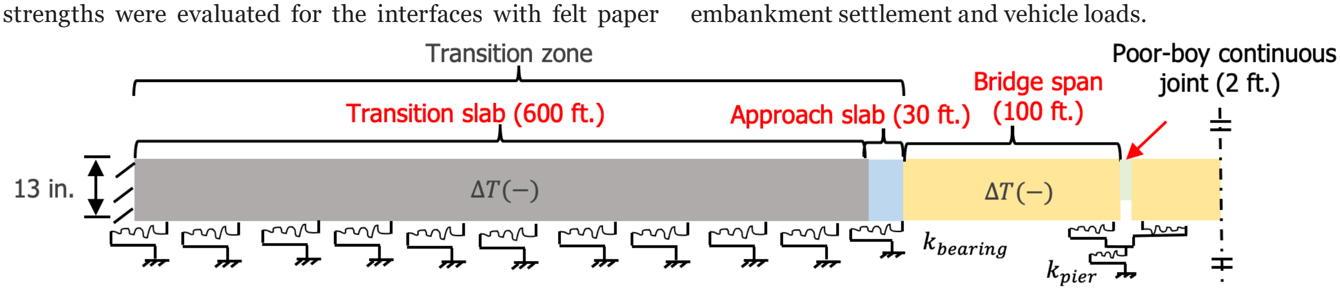
SUPERVISORS: TODD HELWIG & JORGE ZORNBERG

EXTERNAL ADVISORS: JUAN MURCIA-DELSO

The seamless continuously reinforced concrete pavement (CRCP)-bridge system eliminates the expansion joints over the bridge abutment and at the end of approach slab, which can reduce maintenance costs, minimize the bumps and noises, and improve the durability. A transition zone between CRCP and bridge will be designed to accommodate the additional effects due to the seamless connection.

The research team aimed to identify the bond breakers at the slab-base interface within the transition zone through a comprehensive two-phase experimental program. The shear strengths were evaluated for the interfaces with felt paper and spike HDPE sheet by conducting cyclic push-off tests. The felt paper provided a desired coefficient of friction for the seamless system. The effects of cyclic movements on the interface restraint were insignificant.

One-dimensional nonlinear finite element models were developed in Abaqus to simulate the axial behavior of the transition slab. The effects of slab-base interaction, reinforcement ratio, slab thickness, and temperature change were investigated. Two-dimensional FEM model is developed to analyze the bending behavior under the differential embankment settlement and vehicle loads.



Scheme of Abaqus model for seamless system

PROPOSED MODIFICATIONS TO AASHTO CROSS-FRAME ANALYSIS AND DESIGN (WT EXTENSION)

PROJECT TEAM: SUNGHYUN PARK

EXTERNAL ADVISORS: MATT REICHENBACH

SUPERVISORS: TODD HELWIG & MICHAEL ENGELHARDT

Cross-frame systems consist of not only the cross-frame member itself, but also often connection and gusset plates. The cross-frame member is often fastened about only one leg (for angles) or only the flange or stem (for WTs). The nature of this connection introduces eccentricities about one or more axes, which inherently impacts the relative stiffness of the cross-frame.

One of the major objects of the original NCHRP Project 12-113 study was "Additional guidance on how to handle the influence of end connections on cross-frame member stiffness in refined analysis models." The scope of the original study focused exclusively on single-angle sections as cross-frame members. Structural tee sections (referred to as WTs herein), however, are also commonly used by states such as Florida. As such, the intent of this extension study is to revisit the object by investigating cross-frames comprised of WT sections.

This extended WT study includes 1. Laboratory experiments, 2. Validation of FEA models, and 3. Parametric FEA studies. The research team has completed all the tasks, and currently working on the final report.

MTS load frame with installed specimen

DEVELOP GUIDANCE FOR STRUCTURAL BEHAVIOR OF TALL HAUNCHES IN TXDOT BEAM AND GIRDER BRIDGES

RESEARCH TEAM: NIDHI KHARE & ZHENGHAO ZHANG

SUPERVISORS: ERIC WILLIAMSON, TODD HELWIG, & OGUZHAN BAYRAK

This research project focuses on the behavior of both steel and prestressed concrete girder bridges with tall haunches. The haunch is a cast-in-place structural component between the top of a steel or prestressed concrete girder and the bottom of the deck. A primary function of haunches is to maintain a uniform deck thickness, accounting for camber and cross-slope. Due to design errors, construction errors, or unusual geometry demands, actual haunch sizes could exceed the limits specified in current design specifications. To understand the behavior and limit states of girders with tall haunches, the research team is conducting full-scale push-out tests considering a wide range of design parameters. The push-out tests are performed using a self-reacting frame (shown in the accompanying figure). The team has performed 13 push-out tests in the past year and is planning to perform 17 more. The ultimate shear capacity and the load-slip relationship are the most important test data reflecting the behavior of tall haunches specimens. Additionally, detailed computational models are being developed for conducting a parametric study to understand limit states and ultimate capacities for the range of haunch dimensions encountered by TxDOT. Results from the testing program and parametric finite element analyses will be used to develop design and detailing guidelines for girders with tall haunches.

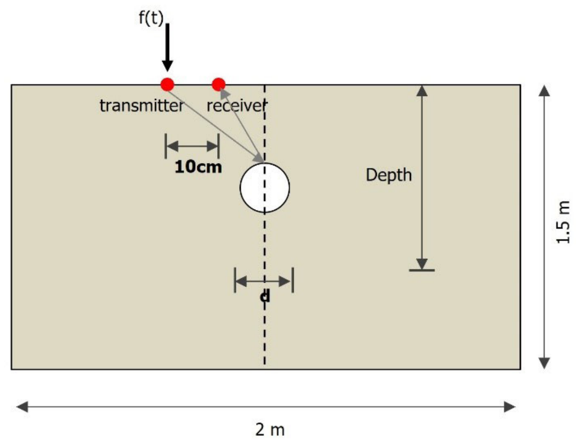
Self-Reacting Test Setup

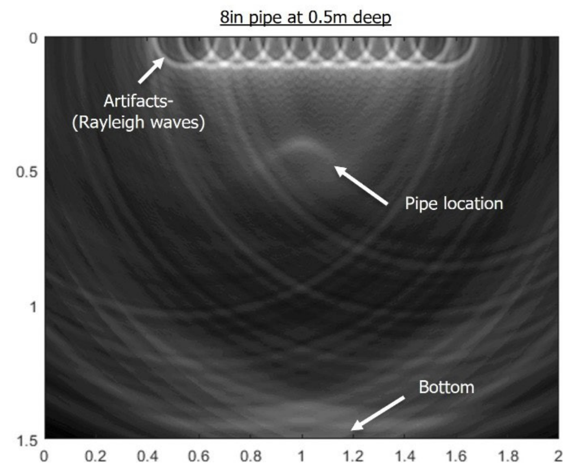
DEVELOPMENT OF A SENSING SYSTEM FOR DETECTION OF UNDERGROUND PIPELINES

RESEARCH TEAM: STYLIANOS LIVADIOTIS, JOHN WEBER

SUPERVISOR: SALVATORE SALAMONE

The main objective of this project is to develop a sensing system, based on ultrasonic methods, for detecting underground utility pipelines. These pipes can be either plastic or metallic, have a diameter between 4-10 inches, and typically carry natural gas. A numerical investigation has been performed to examine the sensitivity of elastic sound waves in soil when incident on pipes of different sizes. To this aim, a 2-dimensional (2D) finite element model was created, with the pipe being simulated as a cavity at different depths and different sizes. A localization algorithm based on the synthetic aperture focusing technique (SAFT) has been developed which utilizes the reflection of the P-wave to estimate the location of the pipe. Findings so far, verify the accuracy of the proposed methodology and suggest that pipes with a diameter larger than 4 inches, located less than 2m from the surface can be identified. An experimental test is currently designed to assess the effectiveness of the methodology in a real situation.





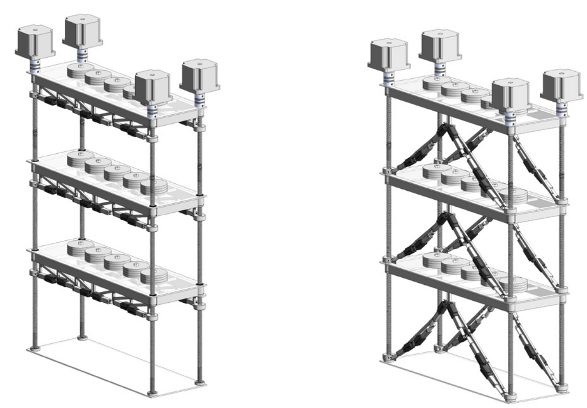
a) The 2D model created in ABAQUS with the pipe being simulated as a cavity and b)

PROOF-OF-CONCEPT: DEPLOYABLE & ADAPTABLE STRUCTURAL SYSTEM FOR SEISMIC HAZARD MITIGATION

PROJECT TEAM: ABHISHEK ARUNACHALAM AGORAMURTHY, RACHEL DWYER, EVAN ROZSA, ROY ALDA, & NEHA AKODE

SUPERVISORS: ERIC WILLIAMSON, LUIS SENTIS, & PATRICIA CLAYTON

In natural-disaster-prone areas, such as high seismic zones, it is necessary to design civil structures for infrequent large lateral force demands. This results in the structure being overdesigned for normal day-to-day loads. The research team proposes implementing an adaptable structural system using deployment technology to mitigate seismic hazards while optimizing the serviceability of the structure. The proposed structural system effectively resists gravity loads in the compact undeployed truss-frame configuration. When excited by an earthquake, the system deploys into a hybrid-controllable braced-frame configuration. Using this structural system reduces the structure's material consumption by utilizing nominal operational energy in buildings located in high seismic zones. The research team has re-conceptualized the system's functioning with respect to the previous edition of the newsletter, published a paper at the SPIE Smart Structures + NDE 2022 Conference, and is now working on prototyping the small-scale structure. Subsequently, they shall test the prototype on the shake table. The simulation's results show that the proposed structural system efficiently handles gravity and seismic loads for the prototype. Hence, the researchers foresee this solution incorporating form-changing deployment along with hybrid control, possibly serving seismic retrofitting applications in existing structures as well as for new structural forms requiring a slender and aesthetic outlook.



3D views of the deployable prototype three-story structure in the undeployed and deployed states

DEVELOP NEXTGEN TEXAS BRIDGE DECK

RESEARCH TEAM: DYLAN GENTRY, CHRISTIAN GALVIN, DENNIS WANG, & ZACH WEBB

SUPERVISOR: OGUZHAN BAYRAK

This project aims to develop design guidelines for a full-width partial-depth precast concrete panel (PCP) bridge deck. In other words, the research team wants to produce a design for partial-depth PCPs that can be used as permanent formwork over the full width of the bridge, including the overhangs. Wire trusses are partially embedded in the panels to achieve this. Considerable ground has been covered now in Task 3, which is the load testing of the PCPs in negative moment using a four-point bending test. Five specimens have been tested so far with more currently curing and awaiting testing. Results thus far are promising, as load resistance and behavior has been primarily controlled by the yielding of the top chord in the trusses, providing adequate and predictable behavior. This semester we plan to finish this series of load testing and use the results to develop future guidelines regarding the design and use of these panels in the field. We have also begun the planning and design of Task 4, which consists of load testing of a full-scale bridge deck using the same full-width partial-depth PCPs with a cast-in-place topping.

Test specimen after failure in four-point negative bending test

REFINED DESIGN METHODS FOR LEAN-ON BRACING

PROJECT TEAM: AIDAN BJELLAND, CHEN LIANG, RYAN STEVENS, & CLAIRE GASSER (TEXAS A&M)

EXTERNAL ADVISORS: DR. MATTHEW REICHENBACH

SUPERVISORS: TODD HELWIG, ERIC WILLIAMSON, MICHAEL ENGLEHARDT, MATTHEW HEBDON, STEFAN HURLEBAUS (TEXAS A&M), & MATTHEW YARNOLD (TEXAS A&M)

Cross-frames and diaphragms are provided to improve the lateral-torsional buckling resistance of bridge girders during construction. These components require extensive handling, cutting, and welding during fabrication. The braced locations are also a source of fatigue concerns in the finished bridge. Lean-on bracing is an alternative bracing method that reduces the number of elements in the cross-frames by having several girders ‘lean’ on a single cross frame. Currently, guidance for these lean-on applications is limited. Therefore, the objective of the research project is to develop and refine design guidelines for lean-on bracing applications.

Last semester (Fall 2021), the research team coordinated with the North Texas Tollway Authority and TxDOT to instrument and subsequently conduct live load testing of the Chisholm Trail Parkway Overpass at FM1902B up near Fort Worth. The instrumentation involved installing 128 strain gauges and 5 live load cases were tested.

To calibrate finite element models, data from Chisholm Trail, the SH 105 Brazos River Bridge near Navasota and the 19th Street West Bound Bridge in Lubbock will be used. These models will serve as the foundation of parametric studies that will be used to highlight the effects and benefits of lean-on bracing configurations in a wide range of bridge types and aid in the development and refinement of design guidelines.

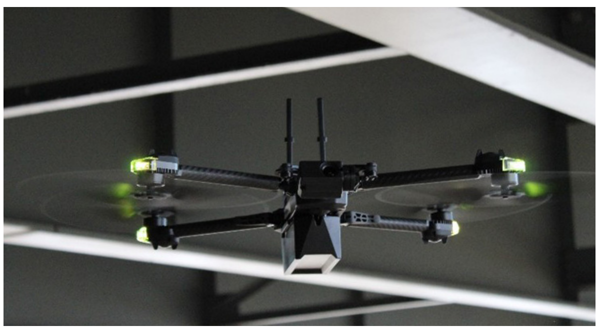
Live Load Testing on the Chisholm Trail Parkway Bridge

PROPOSED AASHTO GUIDELINES FOR APPLICATIONS OF UNMANNED AERIAL SYSTEMS TECHNOLOGIES FOR ELEMENT-LEVEL BRIDGE INSPECTION

PROJECT TEAM: RYAN STEVENS, JOHN ZULEGER (MBI), & JEFF SAMS (MBI)

SUPERVISORS: MATT HEBDON & ALICIA MCCONNELL (MBI)

Bridge inspection is a critical aspect of maintenance required to ensure that roads are safe for travel. Challenges to current inspection processes include access and safety for inspectors and traffic. However, the developments of newer technologies, such as unmanned aerial systems (UAS) are reducing risks and providing valuable tools to assist inspectors in performing these tasks. With many different types of UAS airframes and onboard sensors readily available to consumers, guidance is necessary to direct the correct applications and provide minimum standards for implementation for bridge inspection. The objective of this research is to develop AASHTO guidelines that will enable DOTs and other owners to inspect bridges on an element level. The research team, collaborating with inspectors from Michael Baker International, is developing a selection process for UAS technologies, operator and team qualifications, and providing a comparison between UAS and conventional element-level inspection methods. The team is evaluating 20+ different types of bridges, with their varying bridge element types in various states, to ensure the guidelines are broadly applicable and encompass the vast majority of structural types throughout the US.

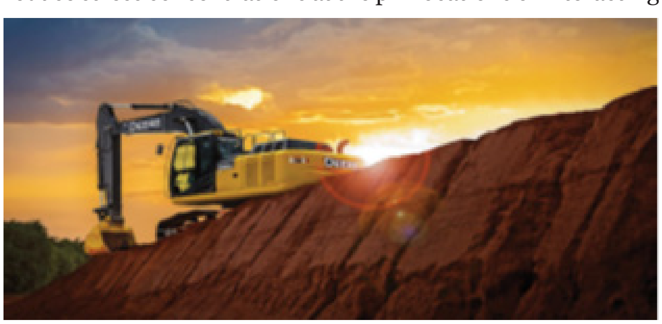


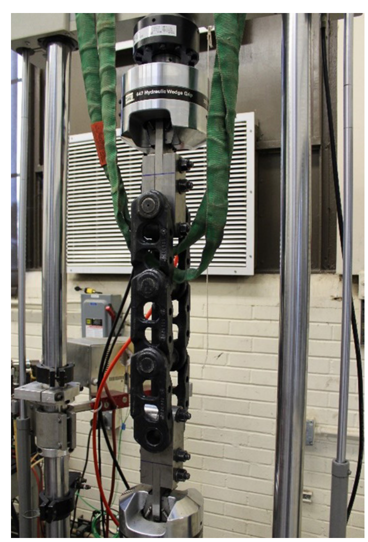
FATIGUE TESTING OF EXCAVATOR TRACK CHAINS

PROJECT TEAM: RYAN STEVENS

SUPERVISOR: MATT HEBDON

A track chain on an excavator is subjected to many severe loads during use in harsh environments. Because the track chains are constantly loaded and unloaded throughout the lifetime of the track, they are susceptible to fatigue crack initiation and potential failure. Through a collaboration between John Deere & Hitachi investigation of a new track chain designed to reduce stress concentrations at the pin locations of interacting chain links where fatigue cracks commonly form is being done. This study is providing constant amplitude fatigue testing of segments of excavator chains to determine whether the new design meets the required fatigue protocol. Two different chain types are being evaluated through fatigue testing in an effort to compare the proposed design with traditionally shaped excavator chain links.





DEVELOPMENT OF NON-FRACTURE CRITICAL STEEL BOX STRADDLE CAPS

PROJECT TEAM: ESTEBAN ZECCHIN, EMMA WILLIAMS, CHEN LIANG, SONITA MANSOORI, MATT REICHENBACH, & SUNGHYUN PARK

SUPERVISORS: TODD HELWIG, MICHAEL ENGELHARDT, MATT HEBDON, & ERIC WILLIAMSON

The main goal of this project is to develop details that allow steel box straddle caps to be classified as internally redundant, thus removing the Fracture Critical designation, providing added safety, and producing significant savings in their life-cycle economy.

Full-scale test setup and specimen

Working in conjunction with industry professionals, the research team developed two primary details for internal redundancy:

1. Adding high-strength bars anchored along the length of the cap in the vicinity of the bottom flange to provide a secondary load path in the event of a fracture;

2. Providing cross-boundary separation by introducing a bolted connection between the bottom flange plate and two flange connection plates welded to the webs.

As part of the full-scale experimental testing tasks, a baseline specimen -without any redundancy detail- was tested to fracture last Fall. Earlier this Spring, the specimen with the cross-boundary separation -bolted bottom flange- was tested to fracture and post-fracture ultimate strength, providing very promising results. Next, the research team will test the specimen with the high-strength bars and a variation of the specimen with the bolted bottom flange. All these tests are performed at lower-shelf temperatures.

Fractured bottom flange plate of specimen with cross-boundary separation (after ultimate strength test)

In the next stage, FE models validated with the experimental test results will be used to conduct parametric studies and develop design recommendations.

SHIP HULL INNER BOTTOM UNREINFORCED OPENINGS

PROJECT TEAM: RYAN STEVENS

SUPERVISOR: MATT HEBDON

Hulls on large naval ships are often constructed with an inner and outer steel skin with many longitudinal and transverse members creating a steel lattice grid to support the structural assemblies required throughout the ship. Within the steel lattice system, ports are required for mechanical access and service. This experimental testing is evaluating proposed modifications to these access ports which would eliminate stiffeners through revised proportioning requirements. These modifications will improve the fabrication process and reduce the welding requirements resulting in a more streamlined fabrication process of the steel lattice frame. Specimens will be tested to evaluate the buckling capacity of the ship hull cross-sections subjected to a combined axial and flexural loading to represent loads experienced at sea.

Test setup and specimen

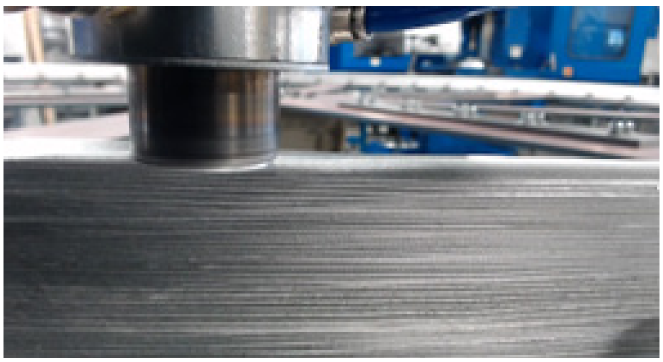
ROBOTIC METAL ADDITIVE MOBILE SOLUTION FOR REPAIR AND UPGRADE OF COMPONENTS USING MELD

PROJECT TEAM: DANIELLE KRUG & RYAN STEVENS

SUPERVISOR: MATT HEBDON

MELD is an additive manufacturing (AM) friction-stir welding process that has favorable potential for structural applications due to its large deposition rate and solid-state process. The MELD process can create components with low residual stresses and are not susceptible to porosity and other issues related to traditional welding processes.

The MELD process is currently being evaluated to determine its potential as part of an Army-funded STTR (Phase II). The research is investigating applications of MELD for rail repair and for railhead buildup to increase carrying capacity. The research will focus on the repair of AISI 1080 rail steel using an Aermet alloy. The research is investigating the microstructure at the interface between the base material and the AM material, as well as the static strength of the hybrid rail section in both positive and negative flexure. In addition, fatigue testing will be performed in both positive and negative flexure on the hybrid sections to determine the appropriate fatigue strength and the potential for crack initiation at the interface of the deposited material.



NEW FACES AT FSEL

FSEL welcomes the new student researchers, Faculty, and Staff members vthat have recently joined us!

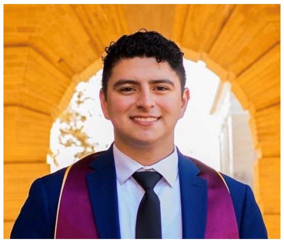
DANIELLE KRUG

I am a first-year Master's student pursuing my M.S. in Structural Engineering. I grew up in the northwest suburbs of Chicago, but my parents hated the cold, so my family now lives in Arizona. I graduated from The University of Alabama (Roll Tide!) in May 2021, where I received my B.S. in Architectural Engineering and graduated with minors in Structural Engineering and Mathematics. During my time at Bama, I was a member of the Steel Bridge team, the President of the Lady Tide Club Soccer team, as well as served on the executive council of my sorority. When I am not in the research lab, I enjoy spending time with my friends, drawing or painting, and playing video games.

ALANA ALVES DE MORAES

I am a first-year Civil Engineering PhD student from Brazil. I graduated with my BS in Civil Engineering Technology from Rochester Institute of Technology in 2020 and received my MS in Civil Engineering at Virginia Tech in 2021. My focus has always been structural engineering, and my research has always been related to corrosion in bridges – steel and prestressed concrete. I am looking forward to learning more about my field and exploring Austin and Texas in general!

DAGOBERTO GARZA



My name is Dagoberto Garza, but I go by Dago for short! I started pursuing my M.S. in Structural Engineering at UT in the Spring of 2022. I am from Houston, Texas, and received my B.S. in Civil Engineering from Texas A&M University in Fall 2021. During my undergrad, I worked several internships focusing on residential and commercial structural building design. This is where my passion for structural engineering grew exponentially. Now I look forward to being a Graduate Research Assistant at Ferguson Structural Engineering Laboratory, where I will be studying the behavior of high-strength steel in bridge decks. Outside of the classroom I enjoy traveling, playing billiards, and running.

CHRISTIAN GALVIN

I was born and raised in Los Angeles, California where my passion for bridges began! I was exposed to the beauty and importance of bridges from a very young age through my parents who are in the transportation industry. I was lucky enough to ride in a helicopter while taking pictures of the numerous historic Los Angeles River Bridges, as well as film them with my hand built drone. I furthered this passion for bridges by completing a B.S. in Civil Engineering from UT Austin in 2021. I am now pursuing a Masters in Structural Engineering under Dr. Bayrak studying NextGen Texas Bridge Deck design here at UT Austin (the best bridge school in the nation). Hook 'em! In my free time, I enjoy cooking tasty meals for friends and family, as well as taking my dog down to Shoal Creek to enjoy nature.

JOHN CHUNSUK PARK

I joined UT as an M.S Student in the Spring of 2022. I received a BS in architectural engineering from INHA University, South Korea. After graduation, I worked as a Civil/Structural Engineer for GS E&C(Formerly LG E&C) and ETEX Group(Belgium Co.) in oil&gas field for about 13 years in South Korea, the Middle East, and the Caspian region. My passion for structural engineering brings me to the University of Texas at Austin, and I am grateful for working as a Research Assistant for FSEL. I enjoy swimming and cooking in my free time, and I also love to teach math to my children.

BEN GRALL

A native central Texan, Ben has been with the University in various roles for 15 years, most recently as the Visitor Services Manager of Texas Memorial Museum. He is a dad, husband, musician, golfer, and enjoys being outdoors and staying active. He loves to create, learn and explore. He's fascinated by the research projects at FSEL and is excited to help facilitate such important and impactful work!

MARK VENTI

Mark joined the FSEL team in March as the new Lab Manager. A former UT student, Mark completed his Master's degree in Civil Engineering in the Spring of 2000. He worked with Dr. Michael Engelhardt on the seismic load performance of reduced beam section (RBS) composite steel moment frame connections. Mark brings with him the experience of a long career in the construction industry. Prior to being a student at UT, Mark worked as a Carpenter and Foreman in the commercial construction industry for 10 years. During that time he attended night school, earning his Bachelor's Degree in Civil Engineering in 1997 from Northeastern University in Boston, MA. After completing his Master's Degree in 2000, he continued his career in construction management, working as a Construction Superintendent and Project Manager for general contractors in New England and Texas. In 2009 he went to work for the Federal Government as a Construction Project Engineer where he spent most of the next 13 years with the US Army Corps of Engineers (USACE) at various locations throughout the US. Mark worked on a wide variety of Military and Civilian projects including Hospitals, Office Buildings, Central Energy Plants, Parking Structures, Training Facilities, Operations Facilities, and Food Service & Dining Facilities. With USACE Mark also worked on Civil Works projects.

MATTHEW HEBDON

Matthew Hebdon, Ph.D., P.E., joined the faculty in the CAEE department in August 2021. Prior to coming to Texas, he served on the faculty at Virginia Tech from 2015-2021. He received his PhD in Civil Engineering in 2015 from Purdue University and earned an MS and BS in civil and environmental engineering from Utah State University in 2005. From 2005 until 2010 he worked as a structural design engineer at Sargent Engineers, Inc., near Jackson Hole, Wyoming. His industry experience included structural design of residential, commercial, and civic buildings, as well as bridge inspection.

His primary research areas include repair and rehabilitation of bridges to extend their service life, corrosion behavior of bridge steels, UAV inspection of infrastructure, fatigue and fracture evaluation of steel structures, structural monitoring and testing, historical fabrication methods and materials, and large-scale testing of structures. Dr. Hebdon actively participates on committees for AASHTO, AISC, AISI, AREMA, and TRB.

Dr. Hebdon enjoys playing most sports, especially volleyball and basketball. He also enjoys woodworking, auto mechanics, and home renovations – there are always too many projects and too little time! He loves spending time with his family hiking, biking, camping, or playing games.

CONTACT US

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